St. Xavier's College (Autonomous), Ahmedabad-380009

M.Sc. Physics Syllabus

Semester-1

CORE Paper: Mathematical Physics-1 & Quantum Mechanics -1
Course Code: PPH-1801
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Use of Fourier transforms and its inverse in practical applications of Physics, apply Laplace transform and its inverse to solve initial value and other related problems.
2. Demonstrate good understanding of basic concepts in group theory, Demonstrate good understanding of various types tensor and will develop basic skills to do tensor algebra
3. Decide whether a given group is cyclic, and given a finite cyclic group, find a generator for a subgroup of a given order, Express a given finite cyclic group as the direct product of cyclic groups of prime power order and, given two direct products of cyclic groups, determine whether or not they are isomorphic
4. Express products of elements of a group defined by generators and relations in appropriate standard form, Understand concept of tensor variables and difference from scalar or vector variables.
5. Understand the reason why the tensor analysis is used and explain usefulness of the tensor analysis,
6. Clarify the basic concepts of perturbation and describe nondegenerate energy levels.
7. Quantum mechanical axioms and the matrix representation of quantum mechanics, apply the variational method and time-independent perturbation theory to solve simple problems
8. Will be able to solve the numericals of the above-mentioned concepts and theory

Course Structure

Unit-1

Integral transform: Integral transform: Introduction, Development of Fourier Integral, Fourier Transforms-Inversion Theorem, Fourier Transforms of derivatives, Laplace transforms, Laplace transform of Derivatives, Properties: Substitution and Translation, Derivative of Transform, Convolution theorem, Inverse Laplace Transform

Unit-2

Group theory: Group, subgroups and classes, Invariant sub groups, factor groups, Homomorphism and Isomorphism, Group representation, Reducible and irreducible representation, Schur's Lemmas, orthogonality theorem, Character of a representation, Character tables, Decomposing a reducible representations into irreducible ones, Construction of representation, Representations of groups and quantum mechanics.
Tensor: Introduction, n-dimensional space, superscripts and subscripts, Coordinate transformations, Indicial summation conventions, Dummy and Real indices, Kronekar delta symbol, Scalars, Contra variant vectors and covariant vectors, Tensors of higher ranks, Algebraic operations, Symmetric and Ant symmetric tensors, Invariant tensors, Conjugate and reciprocal tensors, Relative and absolute tensors, Line element and matrix tensor, Fundamental tensors.

Unit-3

Time-Independent Perturbation Theory: Basic Concepts, Non degenerate Energy levels, Anharmonic oscillator: first order correction, the ground state of Helium, Effect of Electric field on the ground state of Hydrogen, Degenerate Energy levels, Effect of Electric field on the n=2 state of hydrogen, Spin orbit Interaction.
The variation method: The Variation Principal, Rayleigh-Ritz Method, Variation method for excited states. The Hellmann -Feynman Theorem, The ground state of Helium, The ground state of the Deuteron.

Unit-4

Heisenberg Method: The Heisenberg Method, Matrix Representation of Wave function, Matrix Representation of Operator, Properties of Matrix element, Schrodinger Equation in Matrix Form, Eigen value Problems, Unitary Transformations, Linear Harmonic Oscillator: Matrix method
WKB Approximation: The WKB Method, The Connection Formulas, Validity of WKB Method, Barrier Penetration, Alpha Emission, Bound States in a Potential Well

Reference Books

1. Boas M.L., Mathematical methods in the physical sciences, JW,1966
2. Chattopadhyaya P.K., Mathematical Physics, Wiley Eastern Ltd.
3. Arfken G., Mathematical methods for Physicists, Academic Press, 1970

4. Elements of Group Theory: By A W Joshi, New Age Tnt. (2008)
5. Matrices and Tensors in Physics, AW Joshi Third Edition New Age Tnt. (2005)
6. Modern Quantum Mechanics, J. J. Sakurai & Jim Napoliitano, CUP
7. Principles of Quantum Mechanic, R. Shankar, Springer

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M.Sc. Physics Syllabus

Semester-1

CORE Paper: Analog Electronics
Course Code: PPH-1802
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Learn the characteristics of an ideal OPAMP and practical OPAMP.
2. Do analysis of inverting and non-inverting amplifier including different applications of OPAMP through numerical
3. Design and analyse the integrator and differentiator circuit and will solve the linear equation through OPAMP circuits
4. Describe function of each components in Transformer coupled Amplifier, class- A, B, and AB push pull power amplifier.
5. Design the Transformer coupled amplifier, class- A, B, and AB push pull power amplifier and also design Multivibrators
6. Describe the basic principles of complimentary push pull amplifier.
7. Understand the working of 3 terminal and 4 terminal voltage regulator circuits
8. Learn the basics and application of some of the Thyristor family devices
9. Learn depletion and enhancement type of MOSFET, Including the difference between JFET and MOSFET.
10. Understand and learn TTL logic family, CMOS, Gates and interfaces among TTL and CMOS.

Course Structure

Unit-1

Operational Amplifier and its Application: DC characteristics, input bias current, input offset current, input offset voltage, total output offset voltage, thermal drift, slew rate Basic OPAMP application, inverting and non-inverting amplifier, scale changer, inverting summing amplifier, non-inverting summing amplifier, subtractor, Adder- subtractor, Instrumentation amplifier, V to I and I to V converter, half wave rectifier and full wave rectifier, clipper, clamper, Log and Anti.log amplifier, Integrator and differentiator circuit, Electronics analog computation, comparator

Unit-2

Class-A Power Amplifiers: Class-A Power Amplifiers: Class-A direct coupled resistive load, Transformer Coupled Resistive Load, Design Theory, Power Amplifier Design, Harmonic Distortion, Power Output, Variation of Output power with load, Output Transformer Saturation, Disadvantages of a single ended transformer coupled amplifier, Push-pull Amplifier, Description of operation of class-A push-pull Amplifier, Theory of operation of class-A push-pull Amplifier. **Class-B Power Amplifier:** The class-B push-pull Amplifier, Cross Over Distortion, Class-AB push-pull Amplifier, Transistor Phase Inverter, Conversion Efficiency of Class-B Amplifier, Relation between maximum output power and load, Relation between maximum output power and Transistor dissipation, Design of class-8 push-pull amplifier, Other class-B push-pull amplifiers, Complementary Symmetry, Practical complementary symmetry amplifier.
Multivibrators: Astable multivibrator, Monostable muitivibrator, Bistable multivibrator, Schmitt trigger (Transistorised circuit)

Unit-3

IC **voltage regulator:** Internal circuit arrangement, Zener reference regulation protection, error amp, series pass transistor,3 terminal positive voltage regulators,3 terminal negative voltage regulators, 3 and four terminal adjustable voltage regulators, 4 terminal positive voltage regulators, 4 terminal negative voltage regulators, dual non tracking voltage reg, dual tracking voltage regulator.
Thyristor: SCR, Working of SCR, equivalent circuit of SCR, Important terms, V- I characteristics of SCR, SCR in normal operation, SCR H.W. rectifier, SCR F.W. rectifier, Applications of SCR, TRIAC, TRJAC construction, TRIAC operation, TRIAC characteristic, Application of TRIAC

Unit-4

MOSFET: Depletion MOSFET, Enhancement MOSFET, Difference between JFET and MOSFET, Handling precaution for MOSFET, Dual gate MOSFET, Integral gate protection
Logic family: Switching circuit, 7400ITL, TTL parameters, TTL overview, OPEN collector gates, three state TTL device, External drive for TTL loads, 74C00 CMOS, CMOS inverter, NOR and NAND gates, CMOS characteristics, TTL-TO-CMOS interface, CMOS-TO- TTL interface, Emitter coupled logic (ECL)

Reference Books

I. Linear Integrated circuit 4th edition, By Roy Choudhury and Jain, New Age International

2. Integrated Electronics by MillmanHalkias

3. Operational Amplifier by Gayakwad

4. Operational Amplifier and Linear Integrated circuit By Coughlin and Driscoll, Pearson

5. Electronic Devices and Circuit by Allen Mottershead

6. Electronics Devices and Circuits by S. Shalivahanan, N.SureshKumar,TMH.

7. Hand book of Electronics by Kumar and Gupta

8. Electronics Principle by Malvina Bates, TMH

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M.Sc. Physics Syllabus

Semester-1

CORE Paper: Numerical methods and Computer programming in C
Course Code: PPH-1803
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Apply numerical methods to obtain approximate solutions to mathematical problems.
2. Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
3. Understand of Monte-Carlo evaluation of integrals and error and apply in numerical methods.
4. Analyse and evaluate the accuracy of common numerical methods.
5. Implement numerical methods m C Language
6. Be able to perform Monte-Carlo simulations of simple systems,
7. Able to develop C programs.
8. Ability to design and develop Computer programs, analyse, and interprets the concept of pointers, declarations, initialization, operations on pointers and their usage.
9. Able to define data types and use them in simple data processing applications also he/she must be able to use the concept of array of structures.
10. Develop confidence for self-education and ability for life-long learning needed for Computer language.

Course Structure

Unit-1

Numerical Methods: Solution of algebraic and transcendental equations: Iterative, bisection and Newton-Raphson methods, Solution of simultaneous linear equations: Matrix inversion method, Interpolation: Newton and Lagrange formulas, Numerical differentiation, Numerical Integration, Trapezoidal, Simpson and Gaussian quadrature methods, Leastsquare curve fitting, Straight line and polynomial fits, Numerical solution of ordinary differential equations: Euler and Runge-Kutta methods

Unit-2

Simulation: Generation of uniformly distributed random integers, Statistical tests of randomness, Monte-Carlo evaluation of integrals and error analysis, Non-uniform probability distributions, Importance sampling, Rejection method, Metropolis algorithm, Molecular diffusion and Brownian motion as random walk problems and their MonteCarlo simulation

Unit-3

C Language Programming: Basic structure of a C program, Executing a C program, Keywords and identifiers, Variables, C operators, Reading a character, Writing a character, Formatted input, Formatted output, Decision making with if statements, simple if statement, if-else statement, nesting of if-else statements, else if ladder, switch statement, conditional operator, go to statement, While statement, do statement, do while, for statement, jumps in loops - continue and break statements. One dimensional arrays, declaration and initialization of arrays, two dimensional and multi-dimensional array

Unit-4

C Language Programming: Declaring and initializing string variables, reading and writing strings, arithmetic operations on characters, concatenation, comparing, copying and finding length of strings, string handling functions, table of strings. Need for user defined functions, the form of C functions, return values and their types, calling a function, category of functions, noninteger functions, nesting of functions, recursion, functions with arrays, scope visibility and lifetime of variables, ANSI C functions

Reference Books

1. Computer Oriented Numerical Methods: Rajaraman
2. Computational Methods in Physics and Engineering: Wong
3. A Guide to Monte Carlo Simulations in Statistical Physics: Landau and B.inder
4. Applied Numerical Analysis: Gerald
5. Balagurusamy E: Programming in ANSI-C (IInd.Ed.)TMHpub.

6. P.Day and M.Ghosh. Programming in C, Oxford University press,2007
7. Gottfried B.S. Programming with C
8. Kenetker Y. Let us C, BPB pub.
9. Kernighan B.W and Ritchie D.K C programming language, PH pub.

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M.Sc. Physics Syllabus

Semester-1

CORE Paper: Solid State Physics
Course Code: PPH-1804
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Understand Bloch's theorem and what energy bands are and know the fundamental principles of semiconductors
2. Explain the formation of energy band and classify metals, semiconductors and insulators, understand different models and methods like the nearly free electron model, Tight binding approximation, Wigner-Seitz cellular method and Pseudopotential method.
3. Describe Fermi Surface, its construction and will be able to apply it to study the heat capacity, electrical conductivity and thermal conductivity of the material.
4. Distinguish monovalent, divalent, trivalent and tetravalent Fermi surfaces and its characteristics, Describe the electric and magnetic field on Fermi surfaces.
5. A detailed discussion on ferromagnetism and anti-ferromagnetism that make students enable to describe few models like Weiss molecular theory for ferro, hysteresis, and classifications of soft and hard material on that basis.
6. Students can also explain Heisenberg spin and exchange interaction in ferromagnetism super exchange in anti-ferromagnetism
7. Define superconductivity and give a qualitative description of all properties including Meissner effect
8. Show how the London equations and Maxwell's equations lead to the prediction of the Meissner effect.

9. Apply London theory and Ginzburg-Landau theory for superconductivity for type-I and type-II superconductivity based on thermodynamic calculations of the Gibbs free energy for a superconductor
10. Discuss the fundamental theories of superconductivity and their application

Course Structure

Unit-1

Band theory of solids : Review: Developments of energy bands in solids, Electron motion in crystal (one electron approach), Bloch theorem, Kronig-Penny model, Numbers of possible waves functions in a band, Crystal momentum, The concept of effective mass, Concept of holes, Metals, Insulators and semiconductors, From isolated atoms to the free electron limit, The nearly free electron model, Tight binding approximation, Wigner-Seitz cellular method, Orthogonalised Plane Wave (OPW) method, Pseudopotential Method.

Unit-2

Fermi Surfaces: Free electrons, Square Lattice, Variations in the free electron Fermi surface of a square lattice according to valence of the metal, Harisson's construction of Fermi surface for square Bravais lattice (nearly free electrons), Fermi surface Brillouin zone, Divalent metals, Constant energy contours, Fermi surface three dimension lattices, Characteristics of Fermi surface, Effect of electric field on Fermi surface, Closed orbits and open orbits, Topology of orbits in magnetic fields, Experimental determination of the Fermi surface, DE Hass-Wan Alphen effect, Cyclotron resonance in metals.

Unit-3

Magnetic Properties: Ferromagnetism and Antiferromagnetism: Review: Diamagnetism and Paramagnetism. Ferromagnetism (Weiss molecular field theory), A two electron system (Singlet and Triplet) states, Calculation of Singlet Triplet splitting (exchange-splitting), Heisenberg spin Hamiltonian, Heisenberg's exchange interactions in ferromagnets, Ferromagnetism in Iron, Cobalt and Nickel (non-integral values of magnetization), Ferromagnetic domains and Hysteresis, Closure domains, The Bloch wall, Antiferromagnetism, Ferrimagnetism, Direct exchange and super exchange, Super exchange in antiferromagnets, Spin Waves and Magnons, Magnons in a one-dimensional Ferromagnet, Soft and Hard magnetic materials.

Unit-4

Superconductivity: Review: The discovery, Occurrence of superconductivity, The high temperature superconductors, Structure of high-Tc superconductors, Isotope effect, Critical magnetic field, Meissner effect Specific heat, Density of state and energy gape, Thermodynamics of a superconductor, The London theory, Pippard's equation and coherence length, Variation of order parameter across a 'superconductor-normal interface', Type I and Il superconductors, The mixed state, Ginzberg-Landau theory, The Bardeen-Cooper-Schrieffer (BCS) theory of superconductivity, The BCS ground state, Flux quantization, Josephson junction and Josephson effect, SQUTDs, Properties of High Temperature Superconductors (HTSCs), Applications of superconductivity.

Reference Books

1. Solid State Physics, Ajay Kumar Saxena, Macmillan India Limited
2. Essentials of Solid State Physics, SP Kuila, New Central book agency (P) Ltd.
3. Solid State Physics, SO Pillai, New Age International (P) Ltd.
4. Introduction to Solid State Physics, Charles Kittel, Wiley India (P) Ltd, New Delhi
5. Elements of Solid State Physics, J. P. Srivastava, PHI, India.
6. Intermediate Quantum Theory of Crystalline Solids, A. 0. E. animalu, Printice-Hall of India Pvt. Ltd.

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M.Sc. Physics Syllabus

Semester-1

CORE Paper: Electronics Laboratory
Course Code: PPH-1805L
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Will be able to demonstrate the OPAMP parameters.
2. Will be able to demonstrate the OPAMP as inverting or non-inverting amplifiers.
3. Will be able to demonstrate the OPAMP as Voltage to Current and Current to Voltage Converter.
4. Will be able to demonstrate the OPAMP as an Integrator.
5. Will be able to demonstrate the OPAMP as a differentiator.
6. Will be able to demonstrate the Voltage regulator using OPAMP.
7. Will be able to demonstrate the OPAMP as an adder and subtracter.
8. Will be able to demonstrate SV regulated power supply using three terminal IC
9. Will understand the application of OPAMP and practical use.
10. Will be ready to design the circuit using OPAMP characteristics.

Course Structure

1. Study of OPAMP parameters
2. OPAMP as a inverting/non-inverting amplifier

3. OPAMP as V to T and T to V converter
4. OPAMP as an integrator
5. OPAMP as a differentiator
6. Voltage regulator using OPAMP
7. OPAMP as an adder and subtractor
8. 5V regulated power supply using three terminal IC

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M.Sc. Physics Syllabus

Semester-1

CORE Paper: Physics Laboratory
Course Code: PPH-1806L
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Will be able to measure the speed of the sound wave using CRO
2. Will be able to determine the specification rotation of sugar solution using Polarimeter
3. Will be able to measure surface tension of liquid using surface wave
4. Will be able to measure dielectric constant of a non-polar liquid
5. Will be able to measure the energy band gap, voltage coefficient and diffusion capacitance of the PN junction diode.
6. Will be able to measure the resistivity using four probes.
7. Will be able to run scripts in C Language Programming.
8. Will be able to do numerical methods using C Language programming
9. Will understand the application and importance of C Language programming.
10. Will be able to explain importance of physics practical.

Course Structure

1. Measurement of the speed of the sound wave using CRO
2. To determine specification rotation of sugar solution using Polari meter

3. Measurement of surface tension of liquid using surface wave
4. Dielectric constant of a non-polar liquid
5. Measurement of the energy band gap, voltage coefficient and diffusion capacitance of the PN junction diode
6. Measurement of the resistivity using four probes
7. Numerical methods using C Language Programming
8. Numerical methods using C Language Programming